Int. J. Morphol.,
35(4):1298-1302, 2017.

Investigation of the Prevalence of Retromolar Canals: A Cone Beam CT Study

Investigación de la Prevalencia de los Canales Retromolares: Estudio de Tomografía Computarizada de Haz Cónico

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TASSOKER, M. & SENER, S. Investigation of the prevalence of retromolar canals: A cone beam CT study. *Int. J. Morphol., 35(4)*:1298-1302, 2017.

SUMMARY: The retromolar canal (RMC) is a collateral branch of the mandibular canal. This branch seems to be involved in the innervation of the third molar, retromolar trigon and part of the buccal mucosa and fibres of the buccinator and temporalis muscles. The prevalence of RMC in osseous and CBCT studies was reported between 1.7 %-72 %. This study aims to investigate the prevalence of RMCs in a Turkish population using cone beam CT. 340 CBCT images of hemimandibles of 170 patients, with a mean age of 37 (range, 16-80), that clearly identified the course of the mandibular canal in the posterior mandible were selected retrospectively from the archived records of our Oral and Maxillofacial Radiology Department. The sagittal, coronal, axial and pseudopanoramic images were used for assessing the RMCs. This variant was found in 19 out of 170 patients (11 %). Of the 340 CBCT examinations in 170 patients, 20 showed the presence of a RMC (5 %). It was present unilaterally in 18 patients (95 %) and bilaterally in one patient (5 %). There was no difference in the presence of RMCs with regard to sex and sides of the mandible ($p>0.05$). Clinicans should be aware of RMC and this anatomical variance should be taken into consideration while planning surgery around this region. When there is any suspicion of the RMC presence CBCT is the best imaging modality to visualize the three-dimensional structure of this variant.

KEY WORDS: Retromolar canal; Anatomic variation; Cone beam CT.

INTRODUCTION

Knowledge of anatomical structures and anatomical variations of mandible such as supplemental or accessory foramina and canals has vital importance for surgeon and radiologist. One such anatomical variation is bifid mandibular canal (Lizio *et al*., 2013). The retromolar canal (RMC) has been generally studied as a subtype of the bifid mandibular canal called the 'retromolar type' (Han & Park, 2013; Han & Hwang, 2014; Motamedi *et al*., 2016). This bony canal could be the so-called temporal crest canal that was first depicted in 1986 by Ossenberg (1986).

The RMC is positioned within or around the retromolar triangle (Park *et al*., 2016), branches from the main mandibular canal below the third molar and follows a recurrent path, curving in an anterior-superior direction behind the third molar to open in the retromolar foramen (RMF) (Ossenberg, 1987). The RMF is also found in the retromolar trigone, posterior to the last molar (Han & Park). Studies on the RMC and RMF have reported great variety with a prevalence from 1.7 % (Ossenberg, 1986) to 72 % (Patil *et al*., 2013) depending on the study design and the race of the participants.

The content of the RMC has been evaluated in cadaveric, radiologic studies and clinical biopsies (Potu *et al*., 2014). The RMC has a neurovascular bundle which is found to contain predominantly thin myelinated nerve fibers, numerous venules and arterioles covered by collagen bundle fibres and a little amount of adipose tissue (Alves & Deana, 2015; Capote *et al*., 2015; Han & Park; Lizio *et al*.; Motamedi *et al*.; Park *et al*.; Potu *et al*.). The artery in the RMC is the branch of inferior alveolar artery and the nerve derived from the inferior alveolar nerve (Kodera & Hashimoto, 1995; Capote *et al*.). This branch seems to be involved in the innervation of the retromolar trigone mucosa, third molar, part of the buccal mucosa, and fibres of the buccinator and temporalis muscles (Kodera & Hashimoto; Bilecenoglu & Tuncer, 2006).

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There are important surgical procedures in the posterior region of the mandible such as insertion of dental implant, sagittal split osteotomy, bone harvesting procedures, and removal of impacted third molar (Bilecenoglu & Tuncer; Naitoh *et al*., 2009; Park *et al*.; Patil *et al*.). Bilecenoglu & Tuncer reported mean distances of 4.2 mm and 11.9 mm from the RMF to the distal aspect of the alveolar socket of the third and second molars, respectively. Due to the lack of awareness about the presence of RMC, an anesthetic failure can be seen (Capote *et al*.) and an injury of the RMC during surgery in the mandible may result in temporary or permanent paresthesia, anaesthesia, excessive bleeding and traumatic neuroma (Bilecenoglu & Tuncer; Silva *et al*., 2006; von Arx *et al*., 2011). The impingement of the neurovascular bundle in the retromolar trigone from dental removable prosthesis in the elderly due to the resorption of alveolar bone may result in patient discomfort (Langlais *et al*., 1985). Additionally, the RMC may be a possible route for the spread of a tumor or infection (Bilecenoglu & Tuncer).

Conventional two-dimensional radiographs such as panoramic images are widely used in dental practise (Capote *et al*.) but can be insufficient for detecting RMC because of overlapping the anatomical structures and geometric distortion (Park *et al*.). The panoramic radiography studies of the RMC have reported occurence rates of less than 1 % (Kalantar Motamedi *et al*., 2015), so the canal has been considered a rare anatomical variation (Han & Park). Sectional imaging, such as medical computed tomography (CT) and cone beam CT (CBCT) are effective for confirming anatomical variations that cannot be assessed on panoramic radiographs (Han & Park; Park *et al*.). If compared with medical CT, CBCT has the advantages of lower radiation exposure with comparable accuracy and resolution (Lizio *et al*.). Over the past few years, micro-CT systems have been used for the evaluation of the bony canal morphology because of their high resolution (Park *et al*.).

Although RMC is of clinical importance, it has rarely been studied in the dental literature and has generally been neglected in anatomic textbooks (Han & Park; Potu *et al*.; von Arx *et al*.). The aim of this study was to analyze the presence of RMC on CBCT images considering sex.

MATERIAL AND METHOD

This retrospective study protocol approved by the Necmettin Erbakan University Institutional Review Board (Decision no: 2017/2). The study consisted of 170 patients who had undergone CBCT imaging bilaterally for dental implant surgery, impacted third molar surgery, or orthodontic treatment. 340 CBCT images of hemimandibles of 170 patients, with a mean age of 37 (range, 16-80), that clearly identified the course of the mandibular canal in the posterior mandible were selected retrospectively from the archived records of Necmettin Erbakan University, Department of Oral and Maxillofacial Radiology.

CBCT scanning was performed using Morita 3D Accuitomo machine (J. Morita Mfg. Corp. Kyoto, Japan). The axial, coronal, sagittal and pseudopanoramic reconstructions were used for assessing the RMCs (Fig. 1-2).

All CBCT images were evaluated by the same oral and maxillofacial radiologist twice with a 1-week interval between assessments. All CBCT images were examined in a dark room and in the same computer [Intel® Xeon® E5-2620, 2.0 GHz; NVIDIA quadro 2000; 32" Dell T7600 workstation with a resolution of 1280 x 1024 pixels, 8 GB memory, Windows 7 operating system] with the use of the i-Dixel software Ver. 2.0 (J. Morita MFG. Co.).

Statistical analysis was performed by SPSS version 21.0 (Statistical Package for Social Science Inc., Chicago,

Fig. 1. Reformatted pseudopanoramic CBCT image shows the unilateral RMC on the right side of the patient (arrows).

Fig. 2. Sagittal CBCT section shows the RMC (arrows).

IL). Data set was analyzed using descriptive statistics and chi-squared test. The reliability of data were analyzed using the kappa test, p values less than 0.05 was considered to be significant. The kappa coefficient was interpreted as being poor (0), slight (0.01–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), and almost perfect (0.81–1.0), according to Landis & Koch (1977).

RESULTS

The study sample comprised the CBCT images of 95 female and 85 male patients. The kappa coefficient for intra-observer consistency indicated almost perfect agreement. The RMC was observed in 19 out of 170 patients (11 %). Of the 340 CBCT examinations in 170 patients, 20 showed the presence of a RMC (5 %). It was present unilaterally in 18 patients (95 %) and bilaterally in one patient (5 %). There was no significant difference in the presence of RMCs with regard to sex and sides of the mandible ($p>0.05$).

DISCUSSION

The panoramic radiograph is the initial radiographic examination tool for a general evaluation of the patient in dentistry (Capote *et al*.). The most common three-dimensional imaging techniques used to study jaw anatomy are medical CT and CBCT (Lizio *et al*.). Naitoh *et al*. (2010) reported that various mandibular anatomical structures can be examined with equal accuracy using CBCT and medical CT. CBCT examination has been recommended as a low cost method with an effective radiation dose less than that of medical CT and slightly higher than that of panoramic radiography (Orhan *et al*., 2011). CBCT is necessary to increase the chance of detection of RMC but subjecting a patient to a CBCT only for this aim may not be ethical (Motamedi *et al*.).

CBCT studies have reported a much higher prevalence for the RMC (Han & Park; Han & Hwang; Patil *et al*.; von Arx *et al*.) than did those using panoramic radiography. CBCT can be used to confirm different anatomical variations of the mandibular canal that cannot be evaluated with conventional radiographic techniques (Han & Park). Von Arx *et al*. found that presence of the RMC in 25.6 % of CBCTs and in 5.8 % of panoramic radiographs.

Kalantar Motamedi *et al*. reported that the prevalence of RMC or type I bifid mandibular canal detected on panoramic radiographs was less than 1 %. Because of the RMC is generally very narrow, conventional radiography is not reliable in detecting RMC (Han & Park; Motamedi *et al*.). Mandibular canal variations may present false-positive images on panoramic radiographs due to the overlapping of anatomical structures in this technique. Moreover, ghost shadows created by the opposite hemimandible, soft palate, pharyngeal airway and uvula may cause false-negative images (Capote *et al*.).

Due to the lack of three-dimensional visualization of the mandible we preferred to use CBCT images in this retrospective study. Previous studies in dry mandibles and by CBCT evaluation have showed that the prevalence of the RMC has a wide range between 1.7 % (Ossenberg, 1986) to 72 % (Schejtman *et al*., 1967) (Table I). The varying prevalence of RMC was attributed to ethnic differences (Han & Hwang; Sawyer & Kiely, 1991), hereditary and enviromental influences such as nutrition, stress (Ossenberg,

Table I. The results of RMC studies in literature.

Studies	Year	Number of Mandibles Studied	Type of Study	Population	Prevalence of RMC
Schejtman *et al.*	1967	18	osseous	Argentine Aborigines	72
Ossenberg	1986	2391	osseous	North American	1.7
Sawyer & Kiely	1991	234	osseous	American	7.7
Pyle *et al.*	1999	475	osseous	Afro-American and Caucasian	7.8
Bilecenoglu & Tuncer	2006	40	osseous	Turkish	25
von Arx *et al.*	2011	121	Radiological: CBCT	Swiss	25.6
Patil *et al.*	2013	171	Radiological: CBCT	Japanese	65
Han & Hwang	2014	446	Radiological: CBCT	Korean	8.5
Capote *et al.*	2015	500	Radiological: Panoramic radiograph	Brazilian	8.8
Motamedi *et al.*	2016	136	osseous	Iranian	40.4
Present study	2017	170	Radiological: CBCT	Turkish	11

1987) and the discrepancy of study design (Alves & Deana; Capote *et al*.; Park *et al*.). The diversity between the dry mandible and fresh cadaver studies can be explained with the RMF being lost due to the atrophic changes in dried bone (Motamedi *et al*.).

Park *et al*. (2016), reported that the prevalence of RMF was 33.6 % according to macroscopic examination of cadaver mandibles whereas the prevalence of RMF/RMC on CBCT was 11.5 %. They concluded that the ability to detect an RMC using CBCT is limited compared with direct anatomical observation. However, CBCT is the best method for identifying RMC in the clinic (Park *et al*.).

In the present study, a prevalence of 11 % was obtained and this was found in the range of other CBCT studies (Han & Hwang; Patil *et al*.). Our results revealed that there was no difference in the occurence of RMCs with regard to sex and sides of the mandible as reported in previous studies (Sagne *et al*., 1977; Bilecenoglu & Tuncer; Ossenberg 1987; Pyle *et al*., 1999; Patil *et al*.; Priya *et al*., 2005; Sawyer & Kiely; von Arx *et al*.). Some researchers (Han & Hwang) reported greater frequency on the right side, while others (Priya *et al*.) reported greater frequency on the left side. We observed that a majority of subjects with unilateral RMCs (95 %) and most of the studies (Bilecenoglu & Tuncer; Ossenberg, 1987; Patil *et al*.; Priya *et al*.; Sawyer & Kiely; Schejtman *et al*.; von Arx *et al*.) in the literature have reported that RMCs ocur unilaterally in contrast to a study by Sagne *et al*.

Capote *et al*. revealed that the average length and width of the RMC were 12.84 mm and 1.33 mm on the right side and 14.11 mm and 1.49 mm on the left side, respectively. The mean diameter values of the RMF was calculated 1.03 mm in the study of Filo *et al*. (2015) by using CBCT images. Motamedi *et al*. found the RMF closer to the buccal cortex than the lingual cortex and RMF size larger in male cadavers. They explained the difference between males and females by the fact that men usually have larger mandibles.

CONCLUSION

Our results revealed that the RMC shows no differences between sexes, can be unilateral or bilateral and presents no side preference. Evaluation of presence of the RMC is of great importance and clinicans should be aware of RMC and this anatomical variance should be taken into consideration while planning surgery in retromolar area such as third molar extraction, orthognathic surgery or installation of osseointegrated implants. When there is any suspicion of the RMC presence CBCT is the best imaging modality to visualize the three-dimensional structure of this variant.

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RESUMEN: El canal retromolar (CRM) es una rama colateral del canal mandibular. Esta rama parece estar comprometida en la inervación del tercer molar, el trígono retromolar parte de la mucosa oral y de las fibras de los músculos buccinador y temporal. La prevalencia de CRM se ha reportado entre el 1,7 % -72 % en estudios óseos y de tomografía computarizada. Este estudio tuvo como objetivo investigar la prevalencia de CRM en una población turca utilizando tomografía de haz de cono. Se seleccionaron 340 imágenes TCHC de los registros de nuestro Departamento de Radiología Oral y Maxilofacial, de mandíbulas de 170 pacientes con una edad media de 37 años (rango, 16-80), las que identificaban el trayecto del conducto mandibular en la parte posterior de la mandíbula. Se utilizaron las imágenes sagital, coronal, axial y pseudo panorámica para evaluar los CRM. La variante se encontró en 19 de los 170 pacientes (11 %). De los 340 exámenes realizados con TCHC en 170 pacientes, en 20 de éstos se observó la presencia de un CRM (5 %); se observó unilateralmente en 18 pacientes (95 %) y bilateralmente en un paciente (5 %). No hubo diferencias en la presencia de CRM con respecto al sexo y los lados de la mandíbula (p> 0,05). Los clínicos deben considerar el CRM y tener en cuenta esta variación anatómica al planificar la cirugía en esta región. Cuando existe alguna sospecha de la presencia CRM, la TCHC es la mejor modalidad para visualizar la estructura tridimensional de esta variante.

PALABRAS CLAVE: Canal retromolar; Variación anatómica; Haz de cono HC.

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Received:13-02-2017
Accepted:25-08-2017